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ABSTRACT

The 21st century will require educational changes to meet the demands of industry. Workers in the 21st century must come equipped with a repertoire of both science and technology skills. Currently, many employers are concerned about where they will find highly trained and capable employees for the new century. Therefore, it has become increasingly important to provide female students with an opportunity to explore careers in both science and technology. To meet the demands of a technology driven society, all capable students and workers should be given an opportunity to maximize their potential. This paper reviews the current state of gender equity in science and technology, and provides information on a program that addresses the gender equity issues. The goal of the BUGS (Bringing Up Girls in Science) project in the Department of Technology and Cognition at the University of North Texas is to provide educational experiences in an outdoor learning lab and technology exposure for girls in grades four and five that will increase girls' interest, participation, self-concept, knowledge, and achievement in the environmental sciences and in technology. (Contains 20 references.) (Author/AEF)

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Minimizing the Gender Equity Gap in Science and Technology

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Abstract:

The 21st century will require educational changes to meet the demands of industry. Workers in the 21st century must come equipped with a repertoire of both science and technology skills. Currently, many employers are concerned about where they will find highly trained and capable employees for the new century. Therefore, it has become increasingly important to provide female students an opportunity to explore careers in both science and technology. If we are to meet the demands of our technology driven society, all capable students and workers should be given an opportunity to maximize his/her potential. This article reviews the current state of gender equity in science and technology, and provides information on a program that addresses the gender equity issues.

In the Department of Technology and Cognition at the University of North Texas a demonstration project, Br*inging Up Girls in Science* (BUGS), funded by the National Science Foundation is now underway. The goal of this project is to provide: educational experiences in an outdoor learning lab and technology exposure for girls, in grades four and five that will increase girls' interest, participation, self-concept, knowledge, and achievement in the environmental sciences and in technology. The project is the result of an extensive review of the literature on "best practices" for providing effective programs for girls to increase the number of females who choose science and technology careers. The BUGS project is an attempt to bring theory into practice with the help of technology.

Methodology

Thirty-six 4th and 5th grade girls (BUGS participants) currently participate in an after school outdoors science lab at Sam Houston Elementary in the Denton Independent School District in Denton, TX. The contrast group is also participating in two science related over-night field trips; one to a zoo and another to Sea World. Participants for the project were recruited from across the district. As part of the study, BUGS participants are mentored by female high school students enrolled in the Texas Academy for Mathematics and Science (TAMS). TAMS provides an opportunity for talented students in mathematics and science to complete the first two years of college while earning a high school diploma. Each TAMS student will be matched with a BUGS participant. TAMS students will also serve as instructional aides for the outdoor lab. Each TAMS student assists a BUGS participant in developing a science fair project and a hands-on demonstration of a concept learned in the lab that will be presented to parents and future BUGS participants. A two-week summer experience at the University of North Texas' Environmental

Education Center, Elm Fork, will be provided for the academic year participants. TAMS students will serve as educational aides while graduate students in environmental science provide instruction. To increase technology skills for the BUGS participants a project WEB site, chat rooms, computer "pen-pals" and two-way audio-video technology have been established.

The Issues of Gender Equity in Science and Technology

According to Baker and Leary (1995) attracting females to science and technology careers has been, for many years, a well-documented problem. Subrahmanyan and Bozonie (1996) argue that crucial areas of science and technology education, particularly for girls, should occur prior to high school. Programs that address gender equity in science and technology at the high school level are often "too little, too late." Science and technology programs for young female students should address the very specific needs of bright and capable female students. Programs should not strive to be equal to programs for male students, but should be equitable, emphasizing hands-on, real-life laboratory experiences while incorporating verbal/language arts components where many females excel. Cooperative learning and mentoring programs are effective methods for incorporating a verbal/language arts component into such programs. It appears to be most important to encourage science and technology participation at an early age. Subrahmanyan and Bozonie document the need to match curriculum to learning styles. To facilitate gender equity in science and technology it is critical to identify programs that provide learner centered materials at an early age.

On the other hand, differences in the use of computers in our schools seem to be mounting in detriment to some of our student populations. Namely – minority, disadvantaged, inner-city, handicapped, rural and females. Neuman (1991) has suggested that these differences were promoted by inequitable access, distribution and use of computers within and across schools. In schools where limited access is further exacerbated by scheduling patterns favoring higher ability students, reasons for students' limited access were identified as being related to location of hardware within schools, unnecessarily difficult pre-requisites for computer courses, lack of handicapped oriented adaptations on the computer systems and stereotyping oriented software (Neuman, 1991; Rothchild, 2000).

Several other studies strongly suggest that differences in the use of computers in the schools exist more due to gender stereotyping than due to capabilities. Capabilities in the cognitive or affective areas have been found to be consistently the same for both genders (Forsyth, 1986; Elliot, 1993). On the other hand, our society's stereotyping through psychological and social processes may be the main contributor of the gender differences in computer skills and subsequent perceptions (Miura, 1986; Nickell, 1987; Eastman, 1984).

As early as 1986, Holligan (et al) point out that not only is the limited access of computer resources a factor, but goes further to say that these reasons coupled with a 4:1 ration of male to female teachers of computing in the high schools may further deter female students from showing any interest in technology. Boys, on the other hand, are in general favored by software themes, given more mastery opportunities, have more role models to emulate, have less fear of machines and seem to express overall a more positive attitude about the benefits of computers in society than do girls (Miura 1986). Nickell (1987) further concurs with Miura and adds that regular use of computers at school and at home positively affects computer attitudes and that society's stereotypes further encourage such usage only in direct relation to the subject's future sex role functional occupation and what expected computer skills will be necessary.

Rationale for Early Involvement in Science and Technology

Hamrick (1990) conducted a study on Women's Perceptions of Science, which indicated that women harbor stereotypical ideas about science and scientists. Most women believe science is a male dominated field with few opportunities for female participation. Weinburgh (1995) conducted

a meta-analysis of the literature on gender differences in students' attitudes toward science. The correlation between students' attitudes towards science and student achievement was explored. Weinburgh concluded that boys display more positive attitudes towards science and that their attitude is highly correlated to their achievement in the subject. Oakes (1990) conducted a study that indicated that the number of students considering careers in the field of science and technology increases very little after ninth grade. Therefore, improving the elementary females' perception of science and technology at an early age would seem to be an essential goal if one is to increase science and technology achievement in female students and subsequently increase the number of females participating in science and technology careers.

Improving Female Involvement in Science and Technology

In a study conducted in 1997, Burkham emphasized the importance of active classroom involvement as a way of promoting gender equity. Methods to increase active involvement include: engage in real life scientific experiments that personify females' interest areas, increase hands-on experience through lab time, allow girls to share research findings through innovative methods that have a strong verbal component (ex. two-way audio visual interaction through the use of the computer), increase opportunities for cooperative learning (Tyler-Wood, 1993).

Technology as a Facilitator

In a recent report, Davis (2000) documented the role that technology can play in an elementary science class designed to increase under-represented female elementary students. Technology can serve as a door-opener or as a gate-keeper for female participation in science. If technology is used appropriately it can serve as a tool to increase an elementary school girl's use of science inquiry and discourse. Possible appropriate use of technology include: conducting science experiments at multiple sites through the use of two-way audio visual technology, the use of chat rooms for scientific discussion, and keeping an on-line journal for science experiments. Davis' research strongly encourages the appropriate use of technology for increasing female participation in science activities at the elementary level.

In 1998, Clements review of the literature finds that computers serve as catalysts for social interaction, with children spending nine times as much time talking with peers while working at computers than while doing puzzles. The review also suggests that the interaction is further influenced by the type of software used and the physical environment surrounding the computer. Beyond Wilson's assertion that the cultural environment has an effect on the content (Stokrocki, 2000), an international study of 303 undergraduate students found that attitude towards computers and computer experience were culture-free constructs. Although the study further confirms that males are more confident about computers than female students, it also found that increased computer experience, number of computer courses completed, and knowledge of computer languages as well as software application packages were enormous contributors to higher confidence levels and overall positive attitudes towards computers (Moon, 1994).

Early on, a similar study conducted, on 247 middle schoolers in the United States, by Eastman & Krendl (1984) had found that the computer task has greater influence on computer achievement than inherent verbal or spatial skills, and that experience using computers reduces sex-related stereotypes. Eastman & Kendl strongly suggest that new technologies foster educational equity.

Conclusions

The literature suggests certain components that should be included in a program designed to increase science and technology career opportunities for females:

1. Hands-on interaction

2. Female teachers as role models
3. Highly capable female mentors for BUGS participants
4. Emphasizing Verbal interaction
5. Working in Groups
6. Using technology to facilitate communication

The BUGS program attempts to move theory into practice by placing proposed promising practices into reality. Currently the program has been under way for a full academic year with all these components in place. Data is being collected on the effects of different components and program practices on the study's population. Analysis of the data will be conducted during the summer. Based on the results, modifications on the procedures and practices of the program will be considered, but the long term impact of BUGS is yet to be determined. Will this theory based program increase the number of females interested in science and technology, and the number of females who obtain high proficiency in skills associated with technology and the environmental sciences? Will BUGS participants enter science and technology careers? Will BUGS participants' achievement scores in science and technology increase?

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